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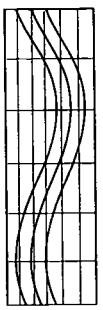
ABSTRACT

One role of counselors and educators is to use assessment in the service of students and clients by monitoring educational progress and ensuring that learning is taking place. Under the right conditions and with proper use, employing technology to foster assessment practices can introduce helpful and productive efficiencies into the educational process. The use of technology as a tool for testing and assessment is the predominant focus of this chapter. It is proposed that to make proper and maximal use of technology tools for assessment, educators will need to: understand the advantages and pitfalls of technology use, particularly as they relate to the use of assessment tools with clients and students; follow the assessment standards and policies of applicable professional associations; use the best practices suggested in this chapter; and stay updated in topics related to assessment and technology. (Contains 41 references.) (GCP)

Harnessing the Power of Technology: Testing and Assessment Applications

By
Janet E. Wall



Chapter 47
Harnessing the Power of Technology
Testing and Assessment Applications

Janet E. Wall

An explosion! An upheaval! A revolution! Those words are often used to describe the remarkable influence of technology on our lives. In his most recent book, Bill Gates speaks of a "web workstyle" and a "web lifestyle" to describe how technology has permeated all aspects of our lives (Gates, 1999). Education has been a prime beneficiary of technology's power. Projections are that more than seven billion dollars was spent on technology in the 2001–2002 school year (QED, 2001a). Computers used for instruction grew to more than 10 million by the beginning of the 1999–2000 school year (Anderson & Ronnkvist, 1999). According to recent information released by Quality Education Data (QED), 97 percent of U.S. public schools are connected to the Internet, 84 percent of classrooms have Internet access, 74 percent of students use the Internet in school for one or more hours per week, and 90 percent of teachers use the Internet as a teaching resource (QED, 2001b). These numbers will continue to grow. As more technology becomes available, it is being integrated more fully into the mainstream of the educational process (Market Data Retrieval Group, 1998; U.S. Department of Education, 2000). The U.S. Department of Commerce (2002) claims that 90 percent of 5- to 17-year-old children use computers, many of them obtaining information over the Internet. Never before has so much information been available to guide individuals in learning, making decisions, and taking actions. Educators who think this technology is another passing fad are sorely out of step.

One role of counselors and educators is to use assessment in the service of students and clients by monitoring educational progress and ensuring that learning is taking place. Under the right conditions and with proper use, employing technology to foster assessment practices can introduce helpful and productive efficiencies into the educational process. The International Society for Technology in Education (2000) published standards and performance indicators in technology for

teachers. The section on assessment and evaluation states that the expectations for educators include these:

- applying technology in assessing student learning of subject matter using a variety of assessment techniques;
- using technology resources to collect and analyze data, interpret results, and communicate findings to improve instructional practice and maximize student learning; and
- applying multiple methods of evaluation to determine appropriate use by students of technology resources for learning, communication, and productivity.

The Collaborative for Technology Standards for School Administrators (2001) advocates that school administrators meet the following standards as they relate to assessment and evaluation:

- use multiple methods to assess and evaluate appropriate uses of technology resources for learning, communication, and productivity;
- use technology to collect and analyze data, interpret results, and communicate findings to improve instructional practice and student learning;
- assess staff knowledge, skills, and performance in employing technology and use the results to facilitate quality professional development and to inform personnel decisions; and
- use technology to assess, evaluate, and manage administrative and operational systems.

Clearly the education profession has high expectations for the use of technology in education, including in testing and assessment. The use of technology as a tool for testing and assessment is the predominant focus of this chapter. To make proper and maximal use of technology tools for assessment, savvy educators will need to

- understand the advantages and pitfalls of technology use, particularly as they relate to the use of assessment tools with clients and students;
- follow the assessment standards and policies of applicable professional associations;
- use the best practices suggested in this chapter to ensure good service to their clientele; and
- stay updated on topics related to assessment and technology.

This chapter provides information to help educators reach those objectives.

Advantages of Assessment Using the Computer and the Internet

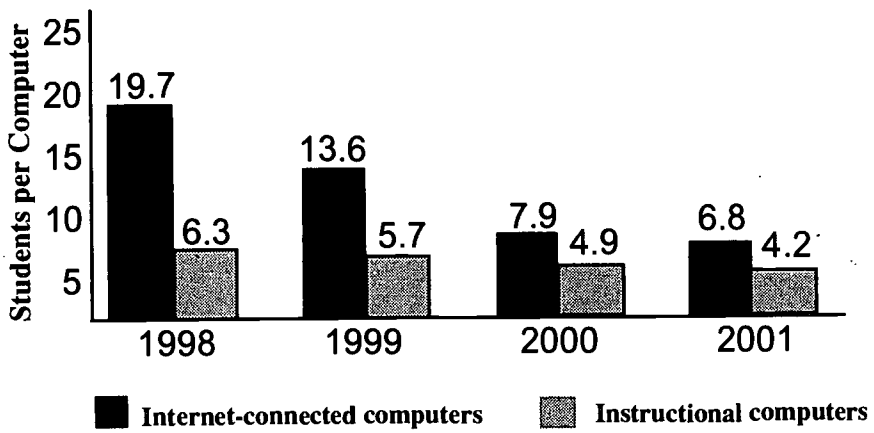
The tools of technology offer educators new capabilities and opportunities to add value to their services to students. These include the following.

Accessibility

Increasing numbers of tests are available via the computer and over the Internet. Individuals can take via computer various tests for many purposes, including college entrance, course placement, certification and licensure, career decision making, academic achievement, military selection and classification, personality assessment, and test preparation. Each year the list expands. The locations where computer-based assessments can be taken range from the privacy of one's home to organized computer laboratories in colleges, high schools, and the private sector. Although some decry the disparity in degree of access to technology among certain groups of people, Bill Gates, in his book *The Road Ahead* (1995), suggests that everyone who is "wired" has access to the same information. Therefore, he proposes that virtual equity is more easily achievable than real-world equity. Negroponte (1995) states, in fact, that the social divide between the information rich and the information poor is more generational than socioeconomic or geographical.

Figure 1 shows the trends of public school students' increasing access to computers. In just a few short years, for example, the number of Internet-connected computers dropped from 1 computer per 19.7 students to 1 per 6.8 students.

Figure 1. Nunber of Students per Computer 1998-2001



Source: Data taken feom "Technology counts 2002," Education Week special report. May 29, 2002.

Immediate Feedback

The proceedings from the National Summit on Education Technology and Assessment (Lemke, 2000) suggests that "technology-based assessment tools provide educators with real-time data, data sensors, and analyses on which to base better decision-making. Through technology, educators will be able to assess learning in ways never before possible." The potential for obtaining real-time data through immediate test scoring and feedback is a key advantage of technology-delivered assessment and can be a significant motivator for persons taking assessment instruments. Individuals can learn their status on assessments quickly and use that information to take immediate action. For example, the immediate availability of results on a college course placement test can assist both students and educators in registering students for the appropriate level of mathematics class or language program. High school students can acquire immediate information about their performance on academic tests and plan their courses accordingly. Students taking an interest inventory can obtain their results promptly and immediately investigate occupations and job openings that fit their interest profiles.

Embedding Assessment in Instruction

The use of technology in the learning process is increasing. Distance education, spurred initially by universities wishing to reach the adult learner, is becoming more prevalent at the high school level (Bennett, 2001, 2002). As students use technology-based instruction, assessment can be embedded into the learning process at appropriate times. Thereby students can gain a good grasp of what they know and where they might need further assistance. Teachers can receive immediate feedback on students' capabilities and plan instruction to alleviate skill deficiencies. Maintaining records of students' status and progress can become easy and automatic.

Where item banks can be made available to educators, tests based on specific objectives can be created, administered, and scored quickly and efficiently, thus providing immediate feedback to both students and teachers. This timely information gives direction for the next steps in the instructional program at a time when interventions are most appropriate and useful.

Ability to Use New Assessment Theories

The use of computerized adaptive testing, as opposed to computer-assisted testing, allows people to take tests that are targeted accurately

to their ability levels (Heubert & Hauser, 1999) basically creating a test reasonably customized to the test taker. Use of technology in combination with the increasingly popular item response theory can determine an individual's performance level using fewer questions than with traditional tests. A RAND Corporation report on web-based testing describes adaptive testing in the following way: "In this type of testing, the examinee responds to an item (or set of items). If the examinee does well on the item(s), then the examinee is asked more difficult items. If the examinee does not answer the item(s) correctly, the examinee is asked easier items. This process continues until the examinee's performance level is determined. Because information about the difficulty of each item is stored in the computer, the examinee's 'score' is affected by the difficulty of the items the examinee is able to answer correctly" (Hamilton, Klein, & Lorie, 2001). The time and money saved by using computerized adaptive testing can be substantial, particularly in large-scale assessment situations or when time is a critical consideration. Attempting to use adaptive testing via paper-and-pencil means would be so burdensome as to be impossible.

Portfolio Assessment

Technology provides one with the capability of placing one's work or educational history in an electronic medium and making that information available to those judging performance or capability. Writing samples, artwork, letters of recommendation, journals, test results, certificates and certifications, verifications of community service, club memberships, project work, and the like can be saved electronically, transported easily (either physically or electronically), and evaluated by others to make decisions related to educational promotion, graduation, job entry, and other purposes. Educators can also observe student progress on various performance requirements and track it over time.

Ability to Assess Higher-Order Skills

Technology permits test developers to use techniques and create situations that are very difficult or impossible to construct in regular paper-and-pencil assessments. Consequently, and with some creativity on the part of the designer, the assessment can reflect more authentic or realistic conditions and may tap into higher-order cognitive skills than a paper-and-pencil instrument can. The use of media, such as audio and video, along with the incorporation of graphics and animation, can enrich the assessment process.

For example, test developers can construct real-world simulations. Test items on computer can simulate events in biology or economics and ask students to take measurements, make observations, analyze results, and propose a theory on how the world works in that subject area. Interactive assessments can present students with new information selected according to their previous decisions, enabling them to test their theory. This interactivity can also yield a more detailed understandings of how individual students approach an assessment situation and can provide insight into their thought process when presented with new information at various stages of the assessment process.

An interactive licensure test in architecture, for example, can simulate the tools an architect would use to create blueprints and engineering drawings, track what tools are selected and how they are used, and determine the design and structural quality of the final product. A technology-delivered foreign language assessment can use audio and video to simulate various situations that would be encountered in the foreign country to assess the students' verbal skills, knowledge of vocabulary, and understanding of the culture and business environment. Having students use the Internet to obtain information on a particular topic then prepare an essay using that information can provide an indication of their information-gathering techniques; abilities to locate, analyze, and synthesize information; and skill in documenting their findings in a well-written and succinct document.

Accommodating People with Disabilities

A powerful use of technology in assessment can be the use of assistive technologies for people with disabilities. Text readers with audio output can help people with visual impairments gain access to testing situations. People with physical impairments can take advantage of voice recognition technology in answering test items, even to the point of dictating long responses to essay questions. Those who experience difficulty with fine motor control can use a touch screen or smart board to respond to assessment items rather than being required to fill out a scannable answer sheet. In fact, computers can be configured with equipment and capabilities that can respond to slight movements of the head or eyes. People who are housebound and unable to travel to a test site can take a test over the Internet from their homes.

Outreach to Others

Technologies such as e-mail, net-meeting, and instant messaging can enable the test taker to reach out to experienced and qualified professionals to obtain further information, test interpretation advice, or discussion of a particular situation or test result. Technologies such as video teleconferencing can enhance assessments through one-on-one interaction between a test administrator and a test taker. This technology can be used to refine assessments when it is important that the test taker be seen and heard. Some applications are able to assess speaking skills, to test foreign language capability by putting a student in touch with persons in foreign countries who can critique language performance, or to determine a person's capabilities through interviews or oral exams. Web cams and video teleconferencing can be powerful tools for test security by providing real-time monitoring of the test administration environment.

Increased Efficiency

To the potential delight of educators, technology-delivered assessment offers efficiencies that can translate into cost savings for schools and districts. Bennett (2001) lists several areas in which electronic media can enhance the testing process. First is the development stage itself. Test items can be written, edited, revised, and managed via technology, reducing the costs of this labor-intensive process. Second, tests do not need to be printed, warehoused, and shipped, thereby saving paper and shipping costs. Third, constructed response items, such as writing samples, can be electronically shipped to scorers, thus eliminating the need to bring scorers to a central location, which accrues travel, food, and housing costs. Additionally, work is under way on automating the scoring process for constructed response items, largely eliminating the need for human readers and scorers. (Thompson, 1999). Fourth, multiple-choice items can be scored immediately, saving the costs of shipping answer sheets and the labor involved in preparing and monitoring the machinery that scores the tests. Last, score reports and interpretations can be sent back to the individual or the school electronically, again saving printing and mailing costs.

Keeping Pace with Curricular Changes and Workforce Needs

In our knowledge-based economy, the skill needs of the workforce are in constant change. The National Governors' Association (2002) believes that what students are being required to learn is outpacing the

content found in the usual paper-and-pencil measures. The Web-Based Education Commission (2000, p. 59) echoed this concern when it indicated that "too often today's tests measure yesterday's skills with yesterday's testing technologies—paper and pencil." Simply put, standardized paper-and-pencil measures are not in sync with the content students are required to learn. Further, typical scoring and reporting procedures are not fast enough to inform classroom instruction or state and local policy.

Disadvantages of Computer- and Internet-Based Assessment

Educators need to be alert to the potential problems and limitations of using technology in assessment situations. Some potential disadvantages are listed in the following sections.

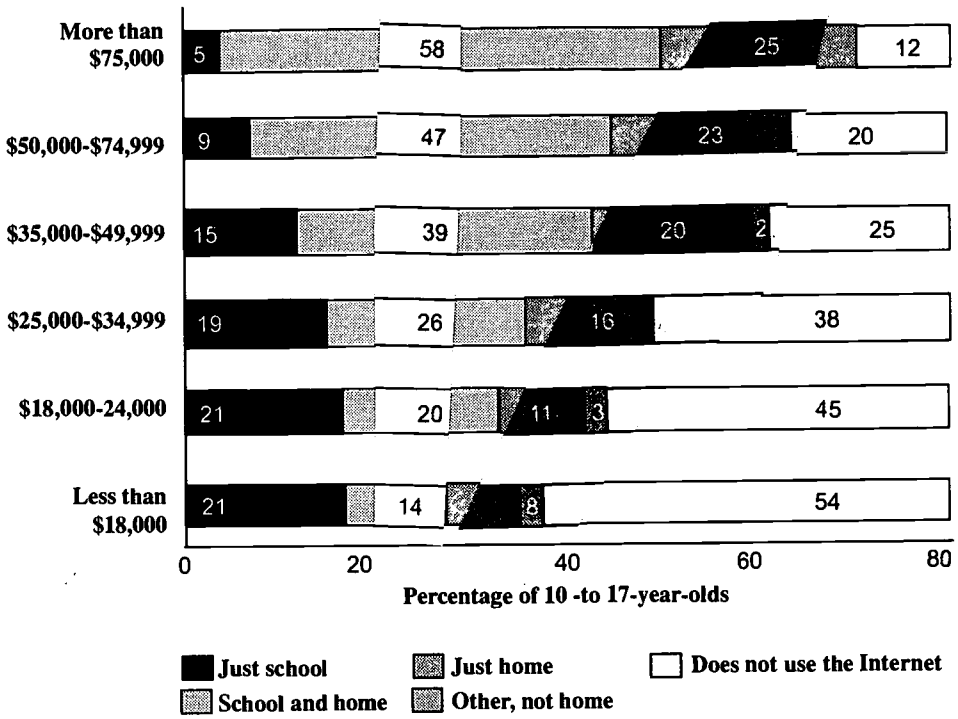
Access to Computers

Whereas some assessments are free, others require payment of a fee. People with limited resources, and especially those without computers, who may in fact be in the greatest need of assessment services, may be blocked from using essential assessments due to resource constraints. A recent Department of Commerce study has shown that access to computers and the Internet is highly dependent on income, racial and ethnic group membership, and urban residence (U.S. Department of Commerce, 1999). Figure 2 shows the relationship between income and computer access. Clearly, about 20 percent of the 10- to 17-year-olds in households with gross incomes below $35,000 had access to a computer only at school. A large percentage did not use the Internet.

Test Security

A major concern related to computerized testing and testing over the Internet is the issue of test security. Test items without suitable security can be compromised, resulting in an unfair advantage to test takers who might obtain the questions prior to taking an exam. In addition, there is the potential for individuals taking assessments via the Internet to acquire information from external sources when answering the test questions. Solutions to test security range from using removable hard drives to tracking or prohibiting access to certain universal resource locators (URLs, Internet addresses).

Figure 2. Students' Access to Computers and the Internet by Income Bracket



Source: Data from U.S. Department of Commerce (2002). *A Nation online: How Americans are expanding their use of the Internet.* Economics and Statistics Administration, National Telecommunications and Information Administration. Washington, DC: Government Printing Office.

Test Taker Identity

Test administrators need to be sure that the person taking the assessment is representing his or her identity accurately. Special care needs to be taken to ensure that the person answering a licensure test for credentialing, for example, is the actual person who is seeking this certification. Various measures can be taken to reduce the degree of uncertainty. Technological solutions to this problem can range from desktop video teleconferencing or web cams to fingerprint recognition systems, facial recognition techniques, and retinal scans.

Privacy and Confidentiality

As with paper-and-pencil assessments, information about an individual's answers and test scores must be kept confidential and be available only to those individuals who have a need to know. This concern is particularly critical for assessments of a delicate or sensitive nature that are answered over the Internet.

Lack of Information on the Quality of the Instrument

Tests taken on computer or over the Internet may not match the quality of paper-and-pencil assessments. Because taking assessments

via the tools of technology is often made to look easy, it may be mistakenly assumed that the test meets professional testing standards. Assuming quality just because a test is available electronically is a dangerous assumption. It is quite possible for a technology-delivered instrument to be deficient in the technical information necessary for a user or test taker to judge the quality and suitability of the instrument. Often little or no information is provided regarding whether the instrument has been normed on an appropriate population, whether the test results have any validity for decision making in the area where the test taker intends to use the results, or whether the test is reliable in assessing a person's condition, status, or performance.

Test Comparability

If an instrument is available in both paper-and-pencil and computer-delivered formats, it may be mistakenly assumed that the two forms produce the same scores regardless of administration format. It is not unusual for some high-quality tests to report different results depending on whether the items are administered via paper and pencil versus computer or Internet. Without the assurance that the test scores are comparable, test takers who take the test in one format may have an advantage over those who take the same test in a different format. For example, several studies have shown that on composition tests where students are required to write responses using paper and pencil, those students who were accustomed to composing on computer received "severely underestimated" scores (Russell & Plati, 2001). Decisions based on inaccurate outcomes may point a student or client in a wrong direction. The discrepancy in results depending on assessment format may occur for any number of reasons including speededness, size of the type, monitor resolution, use of color, comfort with the equipment, or response mode.

Gender, Racial, and Ethnic Bias

That females, persons of color, or individuals of different ethnic backgrounds may be disadvantaged in certain testing situations has been a long-standing concern in paper-and-pencil testing. This problem may be exacerbated with tests delivered via computer or the Internet. If a particular group has disproportionate access to computers and technology, there could be disparity in the test takers' comfort level and familiarity with the use of technology. As a result, test scores could be influenced by both the mode of administration and the content. Recent information, however, suggests that that socioeconomic status—rather

than gender, racial, or ethnic status—is the most likely indicator of access to technology (Hamilton et al., 2001). With continuing increases in all students' comfort level with technology, it is becoming less likely that use of technology will influence test scores in a disparate way.

Reporting and Interpretation

Immediate feedback is clearly desirable. Without appropriate interpretation, though, there is danger that the test taker will take actions that are not warranted by the test results. The potential exists for interpretations to appear so definitive and persuasive that test takers fail to understand the degree of error in the scores and the need for caution surrounding further actions and decisions. Conversely, there may be situations in which the feedback is so extensive that the test results are overinterpreted to the point of paralyzing a person from acting, or that they become like a horoscope with little actual value.

Lack of Human Contact

With technology-delivered assessments, meaningful human contact and intervention to assist with test score interpretation and guidance may be lacking or unavailable. Without a skilled educator or counselor, it may be difficult for a test taker to sort out his or her results and use them in the context of other experiences.

Best Practices in Selecting and Using Technology-Delivered Tests and Assessments

Counselors and educators need to be aware of the various issues related to the construction, production, administration, and interpretation of tests delivered via the computer or Internet. Test users should never compromise on the quality of a test administered to a client or student whether the assessment is in a traditional or technology-delivered format. Various agencies and organization have produced policy statements and standards for testing that are applicable to both paper-and-pencil and technology-delivered assessment. Counselors and educators should be cognizant of and familiar with the premises of these documents when considering the use of technology-delivered assessments. A bibliography of relevant standards and policies is provided at the end of this chapter.

The following section identifies best practices in evaluating and using technology-delivered assessments. The guidelines are consistent with professional standards and are categorized into considerations

relevant to test administration, test quality, test developer credibility, test interpretation, and access to professionals. Adherence to these guidelines is of vital importance when reviewing, selecting, and using technology-delivered assessment instruments.

Test Administration

1. The test setting should be comfortable, quiet, and conducive to allowing the test taker to maximize performance. The arrangement of the computers should ensure privacy and comfort.
2. Testing equipment should be in good working order and the software or Internet programs operating properly. The condition of equipment should be checked prior to each test administration.
3. A site administrator should be available during testing to troubleshoot any equipment, software, or other technology problems that may occur.
4. Policies and procedures for dealing with a technology failure need to be established, explained to the test taker, and consistently applied. For example, if there is a computer crash or power disruption, are the responses to the completed test items saved or does the test taker begin the assessment over?
5. Test takers should be comfortable and familiar with the test format and use of keyboard, mouse, or other equipment. If there is a question about the test takers' familiarity with the technology, practice exercises should be provided to enable them to become facile with the equipment so they can focus on the assessment rather than the mode of delivery.
6. Test items and answers must be protected from compromise. Security of the equipment and test items is critical to the fairness of current and future test administrations.
7. The identity of the test taker should be verified, particularly in high-stakes testing.
8. Tests must be administered according to the procedures specified by the test developer, particularly in cases where standardization is important.
9. Both test users and test takers need to know whether individual score information is stored and, if so, where and for how long. Periodic purges of individual test results stored locally or centrally may be advantageous in maintaining

privacy. It may be more desirable for an individual test user to save test results on a personal disk rather than on a server, computer network, or local computer.

Test Quality

1. The test content should match the purpose of the testing. Assessment items should cover, at least on the face, the areas that the test taker and user desire.
2. The test developer should provide clear and supportable statements about what the test is intended to measure so that test users can ensure that the constructs of the assessment match their intentions.
3. Evidence should be made available by the test developer and reviewed by the test user to ensure that an assessment is appropriate for a prospective test taker with regard to such factors as age, membership in a subgroup, educational level, disability, and language competence.
4. If the test can be administered in paper-and-pencil and technology-delivered formats, test results should be comparable between the two forms. There should be ample evidence that the test scores are comparable or that necessary and appropriate adjustments are made to scores to ensure comparability.
5. Evidence should be provided regarding the conditions under which the test results have been found reliable. The strength of that reliability should be reported by the test developers and examined by the prospective test user.
6. Test results should only be interpreted in ways that are supported by validity evidence. The test developer should present ample evidence regarding the validity of the assessment for particular uses. Care should to be taken to ensure that the test users or test takers apply and interpret the test results for purposes consistent with the validity evidence. For example, if no evidence is provided that the test result validly predicts a future expectation, performance, or condition, then the test should not be used for this purpose until evidence is obtained to support that premise.
7. Limitations of the test and test results should be clearly specified by the test developer and examined by the test users prior to selection of the testing instrument. No assessment is without limitations.

8. The test user should read published assessment reviews written by qualified persons prior to test selection and use.
9. Before selecting a test, the user should examine the items and technical information to determine their currency. If the standardization data or testing forms are antiquated, the user should carefully consider whether the assessment is appropriate.

Credibility of the Developers

1. The test user (and test taker when appropriate) should determine the identity and professional credibility of the test developer. They should examine the developers' qualifications and determine their adequacy. This may be most important when assessments are published by small companies or individuals without a relevant history of quality work.
2. Test developers should provide information indicating whether they abide by the various testing standards of professional organizations. Professional test developers who pledge adherence to testing standards normally attempt to produce high-quality assessments with sufficient technical and research support. Other individuals or organizations may or may not adhere to the standards of quality generally accepted by the profession. *Caveat emptor!*

Test Interpretation

1. If tests are computer- or Internet-delivered, they should be scored and results returned as quickly as possible, and the results should be accompanied by test interpretations that are comprehensive and accurate, given the limitations of the test.
2. Assessment results should not be over- or under-interpreted. Care should be taken not to develop interpretations or explanations that go beyond what can be supported by the reliability and validity evidence.
3. Test reports should specify appropriate and inappropriate uses of the assessment results.
4. Score reports should include an indication of the degree of accuracy of the results.
5. Score interpretations should specify which interpretations are supported by research and which are based on expert

opinion. Sufficient information should be offered to allow the test taker and test user to weigh the credibility of the expert opinion.

6. Test interpretations should describe the limitations of the test and test results, including common misinterpretations.
7. If scores are used in high-stakes decisions such as graduation, promotion, college entrance, placement, or credentialing, the score report should contain information on how the passing or cutoff scores were set.
8. The score and interpretation report should reveal where further information can be obtained about the test and score interpretation, and how a test taker can verify or challenge the accuracy of the score.
9. Where possible, the score report and interpretation should include and incorporate other information about the individual, such as previous test scores, educational level, and performance indicators. This information should be used to help the test taker gain further insight into the meaning of the test results.

Access to Professionals

1. Because it is unlikely that the technology-delivered assessment will incorporate information on the background and experiences of the test taker, a professional educator or counselor should be available to provide value-added interpretations to the assessment information.
2. Where assessment results may require action on the part of the test taker or interventions to change a situation, human assistance is highly desired and should never be totally replaced by technology.

Staying Current

Given that technology is becoming ubiquitous in our daily lives and is likely to continue becoming increasingly integrated into professional educational and counseling procedures, it is important for professionals to keep tabs on the latest developments in the assessment and technology areas. Information on websites frequently is expanded and updated faster than information in print format. For these reasons, chapter 54 lists Internet resources for finding new and important information related to assessment and its marriage with technology.

Check these websites periodically to gather the latest information.

Summary and Look to the Future

Technology is a tool that can assist educators in locating information about assessment, organizing and maintaining test information, building relationships between and among test results and counseling and education interventions, using alternative assessment techniques, assessing difficult areas via traditional and nontraditional formats, introducing efficiencies into the assessment situation, and reaching audiences that are not normally accessible without the availability of certain technologies. Clearly technology can advance opportunities for individuals and guide them in whatever direction they aspire to go.

This has described the capabilities of technology-delivered assessment and outlined relevant precautions. Various guidelines were provided to assist practitioners in using technology and quality assessments to aid individuals in reaching their goals and aspirations. In addition, the chapter listed suggestions for staying current within the field of assessment, particularly as it relates to technology, and the standards and policies on assessment that have been prepared and endorsed by various professional associations and organizations.

As we look to the future and realize that the impact of technology on our lives has just begun, we see several issues with which we will have to wrestle. Among these issues are personal privacy, security, universal access to technology, and the degree of involvement of human interactions in conjunction with technology and the educational process. Perhaps the most poignant of these issues for educators is that the increasing use of technology would seem to ignore the importance of the human touch, which represents the artistic part of education. It is the combination of science and art that can help individuals understand themselves better, know how their characteristics relate to other information, determine how close they are to a desired goal and what modifications they need to make, reach higher achievement levels, and identify what activities and opportunities are available to fulfill their desires and needs. Qualified educators who make accomplished and proficient use of technology can humanize the educational environment. The power and promise of the future exists in the synergy between the best of both high tech and high touch.

Note: This chapter is a revision and update of "Technology-Delivered Assessment: Power, Problems, and Promise," by Janet E. Wall, which appeared in J. Bloom and G. Walz (Eds.), Cybercounseling and Cyberlearning: Strategies and Resources for the Millennium. Alexandria, VA: American Counseling Association.

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